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Subchronic Noise and Metabolism: Rodent Model Identifies Potential Mechanistic Links

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Multiple epidemiologic studies[1,2,3] have linked chronic exposure to environmental noise with an increased risk of metabolic disorders, including obesity and diabetes. An experimental study published recently in *Environmental Health Perspectives* found consistent results in rodents, with gene expression and tissue analyses suggesting potential underlying mechanisms.[4]

Researchers at Université de Picardie Jules Verne in Amiens, France, exposed 12 male Wistar rats to subchronic noise, meaning intermittent noisy periods of relatively long duration. For 37 days, starting at 3 weeks of age, the rats were exposed during their 12-hour sleep period to different sounds at levels comparable to the threshold commonly used in human studies of urban traffic noise. The noise exposure was followed by a noise-free 12-hour active period. Another 12 rats made up the control group.

In the two groups of rats, the researchers compared physiologic parameters, sleep patterns, sleep apnea symptoms, post-sacrifice organ weights, and tissue mRNA expression levels of genes that regulate food intake and appetite. The noise-exposed rats consumed more food and water and gained 6% more body weight than the control animals. They also had heavier thymus and adrenal glands. Forebrain (hypothalamus) mRNA expression levels were higher for one gene (the cocaine- and amphetamine-regulated transcript gene, or *CART*) and lower for another (leptin receptor). Differences in sleep parameters between exposed and nonexposed animals, such as the duration of REM and non-REM sleep, were subtle, and there was no evidence of an effect on apnea during sleep.

"Our study's main finding is that noise exposure during the rest period increased food and water consumption, resulting in body and organ weight gain," says senior author Amandine Pelletier, a lecturer in physiology. "Similar effects have been observed in human studies."[1,2,3]

An association between chronic noise exposure and greater thymus weight was previously reported in female adult rats.[5] That finding suggested that noise-induced stress may influence metabolic function.[6] Another study found that noise exposure increased the adrenal gland production of corticosterone in rats,[7] which may lead to hypertrophy of the organ.[8] Measuring blood levels of corticosterone and other hormones under a similar exposure protocol would be an interesting next step, says Pelletier.

The noise-associated changes in mRNA expression levels may partially explain the observed body weight gain. Leptin is a

Epidemiological evidence has associated chronic noise exposure with metabolic changes, potentially stemming from sleep disturbances. A rat study of noise exposures during regular sleeping hours sought to tease out a mechanism that might explain these observations. Image: © iStockphoto/unoL.

hormone that inhibits hunger.[9,10] The *CART* gene codes for neuropeptides involved in stress and reward pathways, whose expression is partially regulated by leptin.[11] It is plausible that the leptin receptor and *CART* mRNAs may jointly influence circulating levels of leptin and other hormones, contributing to an increased appetite.

Jennifer Teske, an associate professor of nutritional sciences at the University of Arizona in Tucson, who was not involved in the project, notes that an earlier study of rodents[12] reported similar associations between noise exposure and weight gain. Recent work in Teske's lab using female rats also found similar results.[13] The current study's gene expression analysis adds to the body of evidence by suggesting potential underlying mechanisms, she says.

Zorana Jovanovic Andersen, a professor of environmental epidemiology at the University of Copenhagen, notes that, given the rat's life span, the 36-day exposure period mimics long-term exposures that are relevant for human chronic disease development. For Andersen, who also was not involved in the study, the rodent findings are consistent with associations between chronic noise, sleep disturbances, and human diabetes. "The researchers also identified interesting and plausible explanations for these associations," she says, "pointing at noise-related increased appetite and weight gain as the most relevant pathway."

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